Sand Mine Project

Specialist Aquatic Assessment

Baseline Study

March 2022

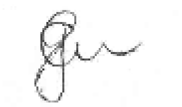
Compiled by:

Juan Potgieter
Pr.Sci.Nat Biological Sciences

Declaration

I, Juan Potgieter, declare that –

- I act as the independent specialist;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.



Signature of specialist

5 April 2022

Date

Executive Summary

This report is based on the results of the sampling survey conducted during March 2022 on the selected sites in the Sand River.

The primary objectives of this project are as follows:

- Determine the biotic integrity (in terms of macro-invertebrates and fish) of the Sand River in the vicinity of the existing sand mine.
- Monitor the present and future impacts of the operation of the sand mining activities on the aquatic ecosystem.

The aquatic ecosystem within the surrounding area of the Sand Mine was assessed as being **largely modified (D)** in relation to the habitat integrity, macro-invertebrate as well as for the fish assessment, after the current survey. The majority of the impacts on this system were associated with agriculture, existing sand mines and instream habitat changes. These modifications in turn influenced the macro-invertebrate and fish community structures. The physical water quality results during the current survey indicated that the water quality was generally good at all of the sites. The main sources for the absence of the expected fish species and macro-invertebrates at all the sites assessed, were from the absence of suitable habitat due to siltation, agriculture and general anthropogenic activities.

As the study area does not fall within a Freshwater Ecological Protected Area (FEPA) it is not governed by its stringent management guidelines. However, normal guidelines should still be adhered to in regards to any development as well as future management of the river.

The impacts of the sand mine in the system were found to cause potential loss of aquatic habitat in the river. The possible impacts will have an effect on the water quality and also on the biotic integrity of the system and needs to be continuously monitored to limit any adverse effects.

Possible mitigation measures towards future impacts from the sand mine development on the freshwater biota are given below:

- The extent of the sand mining area should be limited in order to minimise environmental damage.
- The extraction of river sand should be conducted sustainably and must not compromise the flow of the river or divert the main flow of the river.
- Monitor *in-situ* water quality (including turbidity) upstream and downstream of the mine extent on a monthly basis during extraction activities.

The following recommendations are made, based on the survey:

- Continued bi-annual monitoring of the habitat, macro-invertebrate and fish communities at these sites, which vary seasonally;
- Monitor *in-situ* water quality (including turbidity) upstream and downstream of the mine extent on a monthly basis during extraction activities;
- Monitor siltation within the river segment downstream of activities;
- Monitor algal presence and eutrophication bi-annually.

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List of Acronyms

ASPT	Average Score Per Taxon
DO	Dissolved Oxygen
DWA	Department of Water Affairs (previously known as DWAF)
EC	Ecological Category
EIA	Environmental Impact Assessment
FRAI	Fish Response Assessment Index
FROC	Frequency of Occurrence
GSM	Stones, Gravel, Mud
IHI	Index of Habitat Integrity
IH	Instream habitat
IHAS	Index Habitat Integrity Instream Habitat
SU	Upstream sampling site
SM	Sampling site near existing sand mine
SD	Downstream sampling site
LC	Least Concern
m.a.s.l	Meters above sea level
MAP	The mean annual precipitation
MIRAI	Macroinvertebrate Response Assessment Index
NT	Near Threatened
PES	Present Ecological State
RH	Riparian Habitat
RHI	River Health Index
RHP	River Health Programme
SASS5	South African Scoring System, version 5
ToR	Terms of Reference
TWQR	Target Water Quality Range
WMAs	Water Management Areas
WQ	Water Quality

1. Introduction

Water is one of the most precious natural resources on earth and is utilised extensively for various applications. Rivers create a wide range of benefits to humankind including fisheries, wildlife, and agriculture, urban, industrial and social development close to water sources. The unfortunate effect of these anthropogenic activities is the degradation of the integrity of river systems around the world, due to mismanagement. Management strategies of water resources should be built upon the knowledge and expertise of various disciplines, with the biologist playing an important and sometimes the leading role.

The study site is situated approximately 35 km north of Theunissen and 25km south of Welkom within the Free State Province, on Portion 0 as well as Portion 1 (remaining extent) of the farm De Klerks Kraal No.231 The sand mining operation currently entails the removal of sand from the Sandriver bed. Advantage can be derived from the sand mining activity as it can bring about the diversification of activities on the surrounding property.

Biological communities reflect overall ecological integrity by integrating different stressors over time and thus providing a broad measure of their aggregate impact. The monitoring of biological communities therefore provides a reliable ecological measure of fluctuating environmental conditions. The sampling protocols applied in this project should give a good reflection of the human impacts on the system under investigation. The habitat condition and availability, aquatic macro invertebrates and fish were investigated to determine the Present Ecological Status (PES) of the study area in the Sand river and potential impact of the sand mine on the ecological integrity of the receiving system in its vicinity.

2. Terms of Reference

The Terms of Reference (ToR) for the study were as follows:

- Monitor the possible present and future impacts of the operation of the alluvial sand mine on the aquatic ecosystem.
- Monitoring the PES in terms of water, habitat, macro-invertebrate and fish integrity at sampling points identified during the survey.
- The sampling points were selected to be representative of the area on the Sand River.
- The present study serves to report on the High - flow survey of the aquatic integrity (results from the 12 March 2022 sampling).

3. Project Team

This aquatic ecological assessment was conducted and managed by Nkurenkuru Ecology and Biodiversity. The details of the Aquatic project team are included in Table 3.1.

Table 3.1 Project team with associated areas of specialisation

Specialist	Area of Specialisation	Qualification
Juan Potgieter	Aquatic Ecology	M.Sc. Environmental Management DWA Accredited – SASS Macro-invertebrate monitoring Pr.Sci.Nat
Andre Strydom	Aquatic Ecology	DWA Accredited – SASS Macro-invertebrate monitoring

4. Limitations

Unfortunately, some limitations were encountered even though all attempts were made to take samples under optimal conditions. The limitations to this study included:

4.1. Factors influencing sampling

- The techniques used for assessing habitat integrity were subjective.
- Electro-narcosis was the only technique used for sampling fish, and therefore certain habitats such as deep waters could not be properly sampled.
- Recent high rainfall resulted in high water levels influenced access and sampling.
- Heavy siltation of the river bed influenced access and sampling.

4.2. Factors influencing interpretation

The possible impacts on the river system from the activities could be identified, but not fully quantified. This was due to the presence of other influencing activities in this area, namely agriculture and existing impoundments.

5. Study Site Description

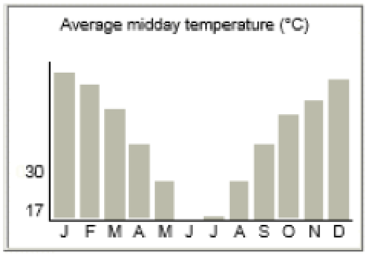
A brief description of the location and biophysical characteristics of the study area that is relevant to the current study is included below.

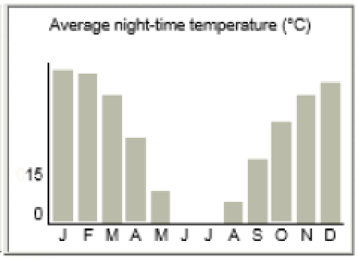
5.1. Location

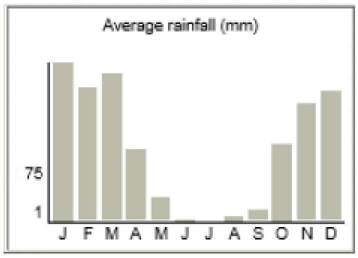
The study site is situated approximately 35 km north of Theunissen and 25km south of Welkom within the Free State Province, on Portion 0 as well as Portion 1 (remaining extent) of the farm De Klerks Kraal No.231 (Figure 6.1-1).

5.2. Climate

Theunissen normally receives about 421mm of rain per year, with most rainfall occurring mainly during summer. It receives the lowest rainfall (1mm) in July and the highest (75mm) in January. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Theunissen range from 17°C in June to 29°C in January. The region is the coldest during June when the mercury drops to 0°C on average during the night. Consult the charts below for an indication of the monthly variation of average minimum daily temperatures and average rainfall (WeatherSA)







5.3. Topography

The topography of the area consists of moderately undulating to flat grassveld plains. The average altitude of the proposed mining area is approximately 1 276 m.a.s.l. The vegetation type for the study area is classified as Highveld Alluvial Vegetation, according to Mucina and Rutherford (2012). The vegetation and landscape features mainly consist of a flat topography with riparian thickets accompanied by seasonally flooded grasslands.

5.4. Geology and Soils

The soil topography of the area is dominated by alternating layers of mudstone and sandstone of the Lower Beaufort Group, (Mucina and Rutherford, 2006). Sandy layers are found covering the clayey subsoils in areas where erosion is absent. The soils have a marked clay accumulation, is strongly structured and has a non-reddish colour. The dominant soils in this land type mainly consists of Estcourt, Rensburg and Oakleaf forms.

5.5. Hydrology

The study area falls within the level 1 Ecoregion 11 according to the South African River Health Programme (RHP) and Kleynhans *et al*. (2005). The aquatic monitoring sites investigated are located within quaternary catchment C42L (Figure 5.5-2), which forms part of the Middle Vaal River Catchment in the Free State. The sampling sites in this study are on the Sand River near the town of Theunissen. The surrounding area consists predominately of commercial farming, including livestock and agriculture. Figure below illustrates the Highveld Ecoregion (green).

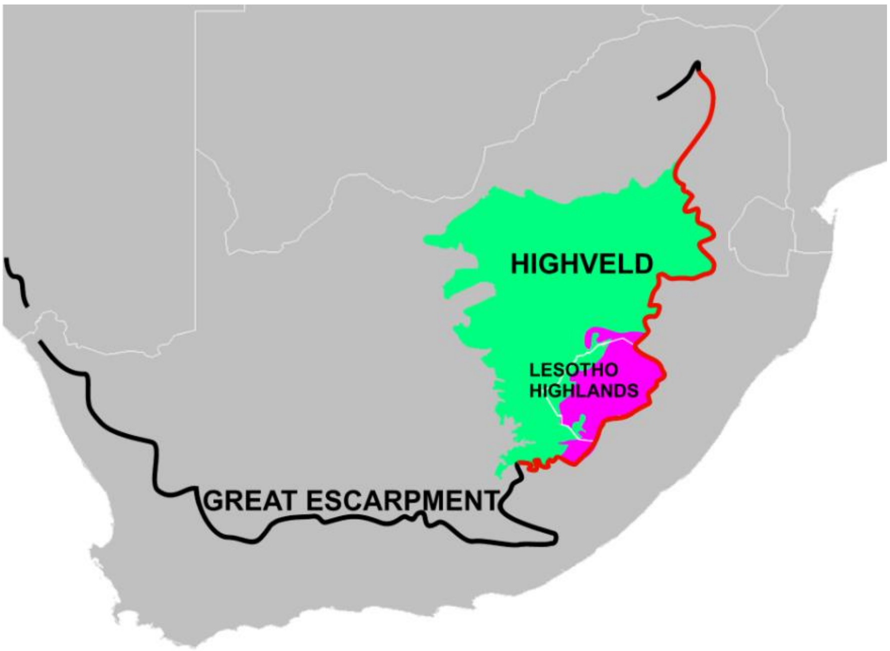


Figure 5.5-1. Illustrating the Highveld Ecoregion.

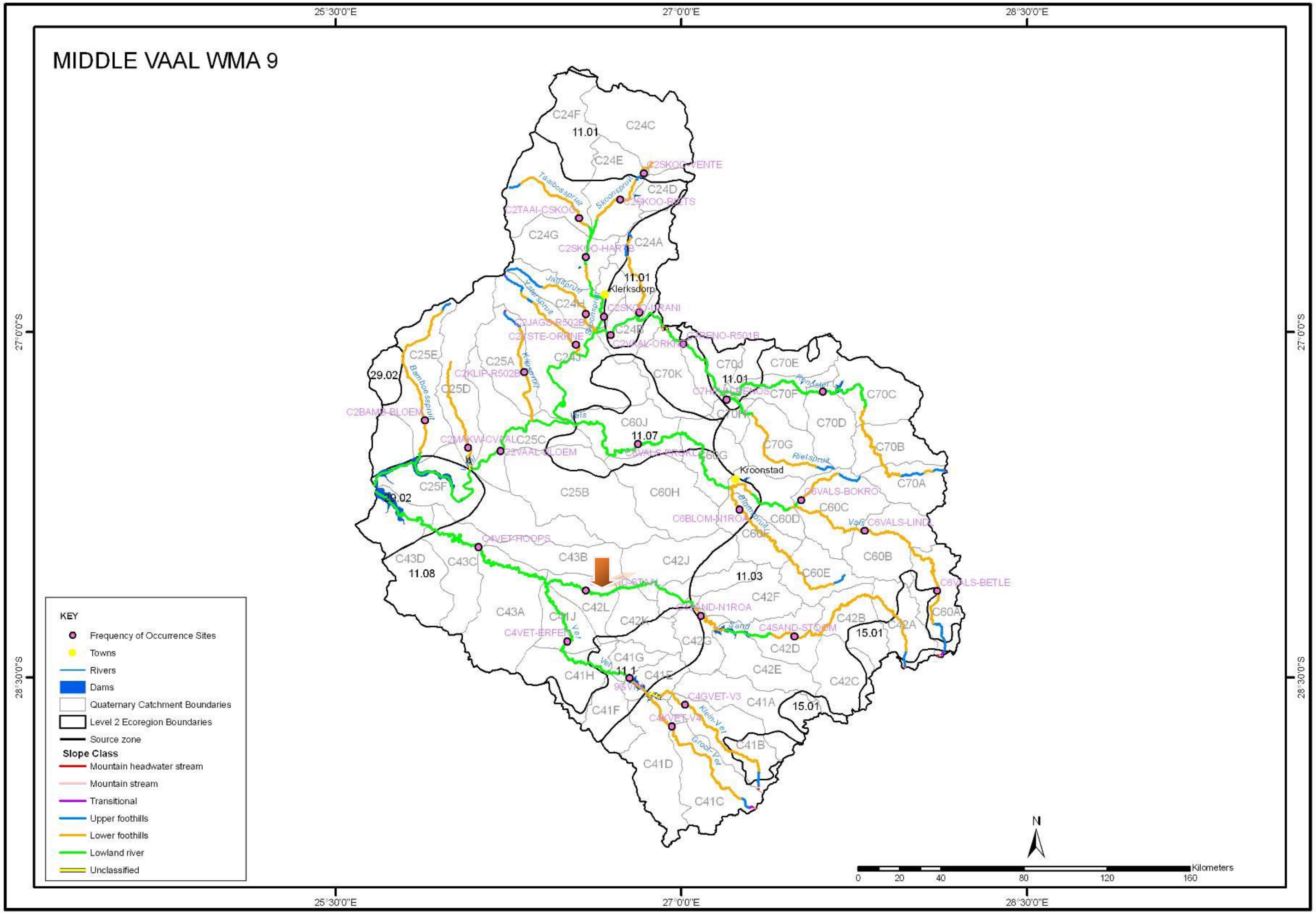


Figure 5.5-2. Quaternary Catchment

6. Methodology

The River Health Programme (RHP), a national biomonitoring programme for South African rivers, was implemented to monitor and thus improve and conserve the health of South African freshwater ecosystems (Todd and Roux, 2000). The RHP specifies that a sampling site must be representative of a river reach, have habitats amendable for sampling and suitable for biomonitoring of the different RHP indices i.e. SASS5, MIRAI and FRAI (DWA, 2008). These indices have been specifically designed for the flowing rivers of South Africa.

6.1. Sampling Site

The primary objective of this study was to establish the present ecological state of the river and impacts of the sand mining plant on the aquatic ecosystems. The survey was undertaken in March 2022. The sites were chosen based on the position of the sand mining plant and to be representing of the available habitats. The survey sites are summarised in Table 6.1.1. The sampling sites are illustrated in Figure 6.1-1 and their positions in the quaternary catchment in Figure 5.5-2.

Table 6.1.1 Selected survey sites

RIVER	SITE POSITION	SITE NAME	LATITUDE	LONGITUDE	SAMPLING DATE
Sand	Upstream of sand mine area	SU	-28.130383°S	26.695990°E	12/03/2022
Sand	Downstream of existing mining area	SM	-28.137827°S	26.670233°E	12/03/2022
Sand	Downstream of sand mine area	SD	-28.144218°S	26.651203°E	12/03/2022

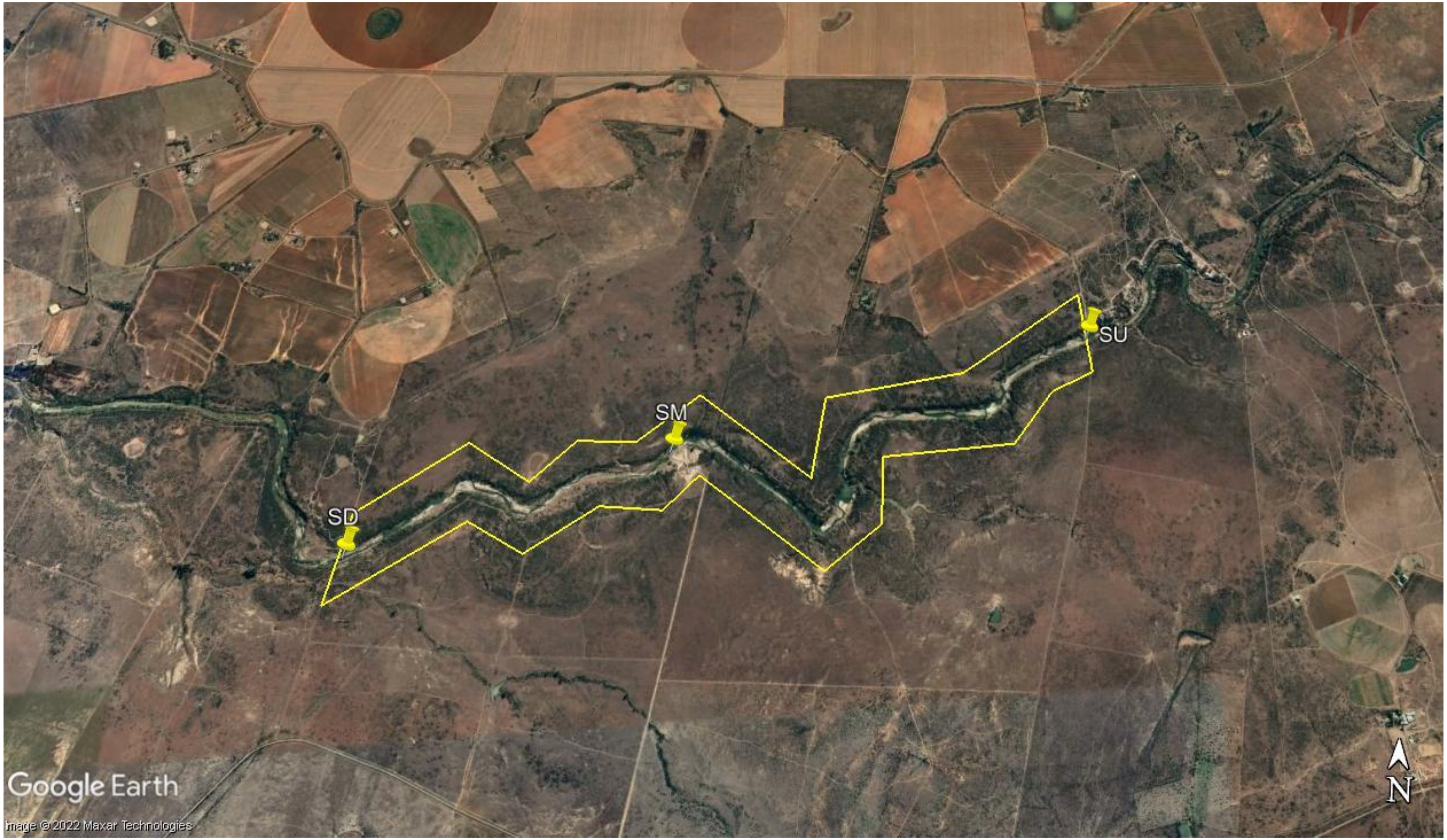


Figure 6.1-1 Aquatic sampling sites

6.2. Present Ecological State

The Present Ecological Status (PES) of the Sand River was determined by assessing the water quality, instream and riparian habitat, macro-invertebrates and fish community integrity. The ecological categories (EC) were used to assist in defining the current ecological condition of a river in terms of the deviation of biophysical components from the natural reference condition (Kleynhans and Louw, 2008). These categories range over a continuum of impacts, from natural (Category A) to critically modified (Category F) and are represented by characteristic colours defined by Kleynhans and Louw (2008) in Table 6.2.1**.** In some cases, there is an uncertainty as to which category a particular entity belongs. This situation falls within the concept of a "fuzzy" boundary, where a particular entity may potentially have membership of both classes. For practical purposes these situations are referred to as boundary categories and are denoted as for example B/C as depicted in Figure 6.2-1. In the current study, the ECs were assigned to the results obtained from the index scores of the IHI and IHAS measuring habitat and FRAI scores measuring fish integrity. The SASS and ASPT scores were assigned ECs based on the Highveld - Upper zone defined by Dallas (2007) and further discussed in Section 6.4.

Table 6.2.1 Present Ecological State codes and descriptions with standardised colour coding (adapted from Kleynhans and Louw, 2008)

CATEGORY	MIRAI, FRAI and IHI (%)	SASS5	ASPT	SHORT DESCRIPTION	LONG DESCRIPTION
A	90 – 100	>/=123	>/=5.6	**Natural**	**Natural** – Unmodified state with no impacts, conditions natural
B	80 – 89	>/=82<123	>/=4.8<2.6	**Largely natural**	**Largely natural** with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged
C	60 – 79	>/=64<82	>/=4.6<4.8	**Moderately modified**	**Moderately modified** – loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged
D	40 – 59	>/=51<64	>=4.2<4.6	**Largely modified**	**Largely modified** – a large loss of natural habitat, biota and basic ecosystem functions has occurred
E	20 – 39	<51	<4.2	**Seriously modified**	**Seriously modified** – the loss of natural habitat, biota and basic ecosystem functions are extensive
F	< 20	<51	<4.2	**Critically modified**	**Critically/Extremely modified** – modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible

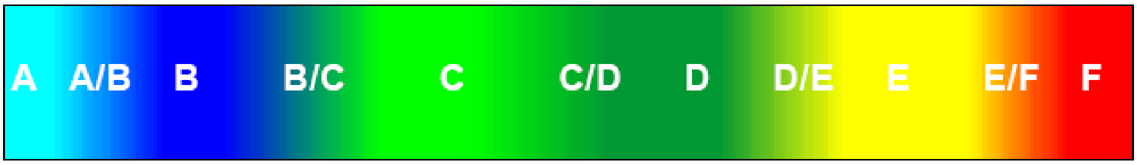


Figure 6.2-1 Illustration of the distribution of categories on a continuum as shown in Kleynhans and Louw (2008)

6.3. Water Quality

Water quality is used to describe the aesthetic, biological, chemical and physical properties of water that determine its condition for a variety of uses and for the protection of the health and integrity of aquatic ecosystems. Constituents in the water, dissolved or suspended, could influence the water quality. In some cases, anthropogenic activities can cause the physico-chemical constituents that occur naturally in the water to become toxic under certain conditions (DWA, 1996).

Determining the effects of changes in water quality on aquatic ecosystems is considered complex. Aquatic ecosystems often appear to have certain thresholds, beyond which it is difficult to recover or regain their functional capacity without mitigation. Each aquatic ecosystem possesses natural limits or thresholds to the extent and frequency of change it can tolerate without being irreversibly altered (DWA, 1996).

6.3.1. Physical water quality parameters

Five physical water quality parameters were measured *in-situ* water quality including temperature, pH, dissolved oxygen percentage and electrical conductivity (EC). The variables were measured in the field by using a HI 9146 Dissolved Oxygen and Temperature Meter and a HI 98129 pH/EC/TDS/Temperature multi-sensor probe (Hanna Instruments). Field measurements were compared against the Target Water Quality Range (TWQR), which is a management objective developed by DWA (1996) for aquatic ecosystems and used to specify the desired or ideal concentration range and/or water quality requirements for each particular constituent.

6.4. Habitat Integrity (IHI)

The Index of Habitat Integrity (IHI) assessment protocol, described by Kleynhans (1996), was used to assess the impacts on the aquatic and surrounding habitats of all the sites sampled. Respectively the instream (IH) and riparian (RH) habitats are analysed based on a set of 12 weighted disturbances in the index. These disturbances represent some of the important and easily quantifiable anthropogenically induced impacts, including bank erosion, bed-, channel- and flow modification; exotic aquatic fauna, -macrophytes and -vegetation encroachment; indigenous vegetation removal; inundation; solid waste disposal and water abstraction. The respective impacts for the IH and RH habitats were calculated. The final IHI was calculated and characterized into one of the six categories defined by Kleynhans and Louw (2008) and indicated in Table 6.2.1.

6.5. Habitat Availability

6.5.1. Habitat Availability for macro-invertebrates

Most aquatic fauna are largely influenced by the habitat diversity within an aquatic ecosystem. As such different biotope diversities for macro-invertebrates were evaluated i.e. stones in current (bedrock, cascade, chute, boulder rapid, riffle and run), stones out of current (bedrock, backwater, slackwater and pool), instream vegetation, marginal vegetation and GSM (gravel, sand and mud). Each of these biotopes were scored, rated on a scale from 0 to 5 according to presence of biotopes, namely absent (0), rare (1), sparse (2), common (3), abundant (4) or entire (5) (Dallas, 2005).

The invertebrate habitat assessment system (IHAS) index was incorporated into the present study. The Invertebrate Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998) to the Sand River in general with assessment sites being selected to be representative of the entire system. This index was used to determine specific habitat suitability for aquatic macro-invertebrates as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index were interpreted according to the guidelines of McMillan (1998) as follows:

- <65% inadequate for supporting a diverse aquatic macro-invertebrate community
- 65%-75% adequate for supporting a diverse aquatic macro-invertebrate community
- >75% highly suited for supporting a diverse aquatic macro-invertebrate community

6.5.2. Fish Habitat Availability

A fish habitat assessment was done to provide a measure of the fish refuge potential associated with each of the sampling sites. This assessment characterises the fish habitats into four velocity-depth classes (including slow-deep, slow-shallow, fast-deep and fast-shallow habitat class, where fast is greater than 0.3 m/s, slow is less than 0.3 m/s, deep is greater than 0.3m and shallow is less than 0.3 m) and associated cover present at each of the habitats (Dallas, 2005). All of these were quantified on a scale from 0 to 5, being absent (0), rare (1), sparse (2), common (3), abundant (4) or entire (5) (Dallas 2005). Measuring these various habitat types are an essential component in the interpretation of the fish integrity because it can influence (by creating or restricting) the fish populations and communities present within each sampling site.

6.6. Macro-invertebrates

Macro-invertebrate communities were sampled using the SASS5 method described by Dickens & Graham (2002). Macro-invertebrates were collected using a standard SASS net in stones, vegetation and gravel, sand and mud (GSM) within specified time frames. Fifteen minutes were taken to identify the presence and approximate abundances of macro-invertebrate families in each of the habitat. SASS5 and MIRAI scores could be calculated to determine the current ecological status of the macro-invertebrates.

6.6.1. SASS5 index

The assessment of macro-invertebrate communities in a river system is a recognised means of determining river "health" (Dickens and Graham, 2002). Macro-invertebrates are good indicators because they are visible, easy to identify and have rapid life cycles. Macro-invertebrate communities were assessed using the SASS5 method described by Dickens & Graham (2002). SASS5 is a rapid assessment index of the macro-invertebrate status of a flowing instream system. As such could not be calculated for non-flowing streams. In the flowing systems, the SASS5 score was calculated by the sum of the sensitivity scores of the present families. The average score per taxon (ASPT) was calculated by dividing the total SASS score by the total number of taxon. The results were interpreted based on the SASS5 interpretation guidelines by Dallas (2007), using the ecological categories derived for the Highveld - Lower Ecoregion (Figure 6.6.1-1) and defined in Table 6.2.1.

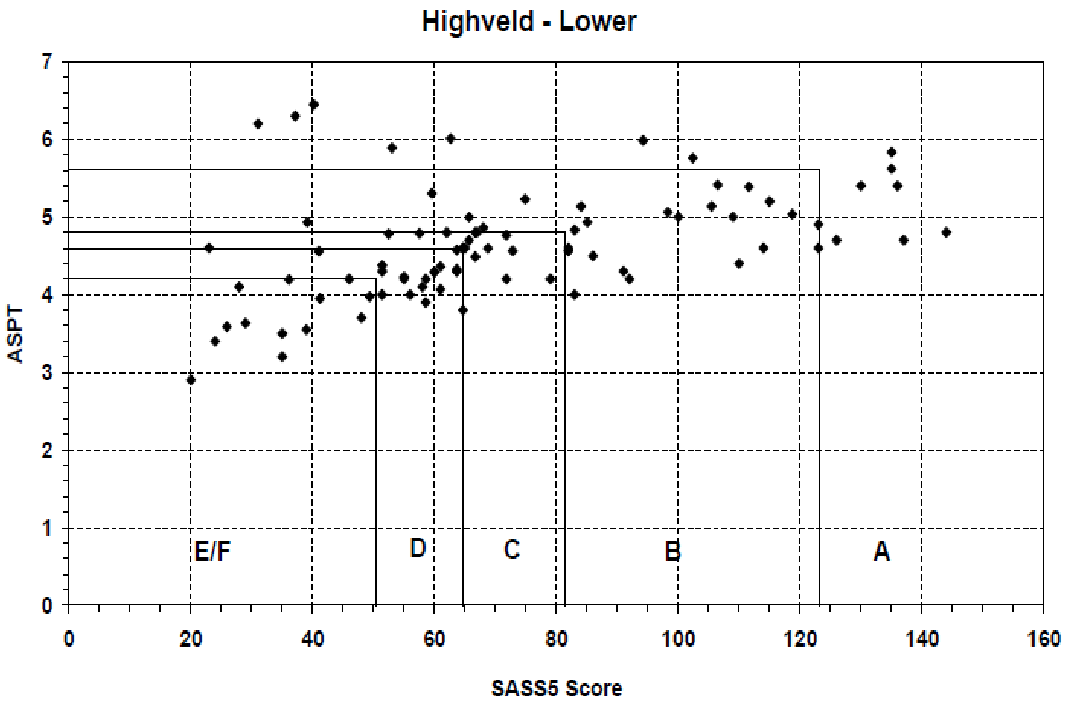


Figure 6.6.1-1 Ecological categories for the Highveld – Lower region, calculated using percentiles (Dallas, 2007)

6.6.2. MIRAI

The MIRAI was incorporated in this study, as an alternative to the SASS5, to determine the PES of the macro-invertebrate community assemblage. The index integrates the ecological requirements of the invertebrate taxa in a community or assemblage and their response to modified habitat conditions, whilst comparing the present assemblage with a reference list (Thirion, 2007). The reference list for this study was derived by using numerous literature sources including historical data from the Rivers Database (2007) and experience within this quaternary catchment and results obtained from the previous studies in the area. In addition, the functional feeding groups and river continuum were considered.

The MIRAI model makes a comparison between the expected macro-invertebrate families with the present assemblages obtained using SASS5 sampling protocol (Thirion, 2007). The habitat preferences for each of the macro-invertebrates were incorporated in terms of flow, habitat and water quality. Each component was rated within a metric in terms of how much the macro-invertebrate presence and abundances changed from reference and were done for each of the metrics. After all the metrics were scored, the model generated a MIRAI score for each site.

6.7. Ichthyofauna

6.7.1. Fish Integrity

The fish community integrity was assessed using the Fish Response Assessment Index (FRAI) developed by Kleynhans (2008). At each site, the fish were sampled according to the methodologies recommended for FRAI. This included sampling fish by means of electro-narcosis in three different river segments (where possible), for approximately 20 minutes in each segment. The sampled fish were identified to species level using Skelton (2001) and safely returned to the aquatic system before they were documented into the separate segments and habitat types. The FRAI model makes a comparison between the expected fish species list obtained from the FROC report by Kleynhans *et al.* (2007) and the FROC of sampled fish species. It incorporates the habitat preferences in terms of velocity-depth, substrate, water quality, alteration in physical-chemical composition of the water, as well as migration requirements of each fish species. The intolerances and preferences are divided into metric groups that relate to the requirements and preferences of individual species. This allows for the understanding of cause-effect relationships between drivers and responses of the fish assemblage to these drivers of change. Having compared the expected list to the actual sampled list, the model generates a FRAI score for each site.

7. Results and Discussion

7.1. Sampling site description

The results for the current field sampling (12 March 2022) are summarised in the tables below and general information for the sites, which are presented in Table 7.1.1,

Table 7.1.2 and Table 7.1.3. The tables are then followed by the water quality, habitat, macro-invertebrate and fish integrity results and discussion.

Table 7.1.1 Survey results and associated information for SU

<table>
<tr><th colspan="10">SU</th></tr>
<tr><th colspan="5">UPSTREAM</th><th colspan="5">DOWNSTREAM</th></tr>
<tr><th colspan="10">2022</th></tr>
<tr><td colspan="5"></td><td colspan="5"></td></tr>
<tr><td colspan="2">River</td><td colspan="8">Sand River</td></tr>
<tr><td colspan="2">Site Description</td><td colspan="8">Perennial river located on the farm, De Klerks Kraal</td></tr>
<tr><td colspan="2">GPS co-ordinates of sampling point</td><td colspan="8">-28.130383°S; 26.695990°E</td></tr>
<tr><td colspan="2">Quaternary Catchment</td><td colspan="8">C42L</td></tr>
<tr><td colspan="2">WMA (Midgley et al. 1994)</td><td colspan="8">Middle Vaal Water Management Area 9</td></tr>
<tr><td colspan="2">Ecoregion Name</td><td colspan="8">Highveld - Lower</td></tr>
<tr><td colspan="2">Regional Vegetation Type</td><td colspan="8">Highveld Alluvial</td></tr>
<tr><td colspan="2">Riparian Vegetation Type</td><td colspan="8">Grasses and Sedges</td></tr>
<tr><td colspan="2">Geomorphological Zonation (Rowntree and Wadeson 2000)</td><td colspan="8">Lowland river</td></tr>
<tr><td colspan="2">Channel Type:</td><td colspan="8">Valley bottom with channel</td></tr>
<tr><td colspan="2">Water Turbidity (Dallas 2005)</td><td colspan="8">Silty</td></tr>
<tr><td colspan="2">Dominant Velocity-depth Classes</td><td colspan="8">Slow shallow, Slow deep</td></tr>
<tr><td colspan="2">Dominant Biotope Diversity</td><td colspan="8">Pools and run</td></tr>
<tr><td colspan="2">Water Quality Parameters</td><td colspan="8">T(°C) = 24; pH = 7.58; EC (mS/m) = 55.80; DO (%) = 82</td></tr>
<tr><td colspan="2">Other Biota</td><td colspan="8">Fish</td></tr>
<tr><td colspan="2">Highly Sensitive Taxa (Score 11-15)</td><td colspan="8">None</td></tr>
<tr><td>DATE</td><td>SAMPLER</td><td>SASS5</td><td>ASPT</td><td>No of Taxa</td><td>PER CLASS</td><td>IHAS</td><td>IHI</td><td>MIRAI</td><td>FRAI</td></tr>
<tr><td>12/03/2022</td><td>A. Strydom</td><td>66</td><td>4.40</td><td>15</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D</td></tr>
<tr><td colspan="2">EXISTING THREATS</td><td colspan="8">• Agriculture
• Flow modifications
• Sedimentation</td></tr>
</table>

Table 7.1.2 Survey results and associated information for SM

<table>
<tr><th colspan="10">SM</th></tr>
<tr><th colspan="4">UPSTREAM</th><th colspan="6">DOWNSTREAM</th></tr>
<tr><th colspan="10">2022</th></tr>
<tr><td colspan="4"></td><td colspan="6"></td></tr>
<tr><td colspan="2">River</td><td colspan="8">Sand River</td></tr>
<tr><td colspan="2">Site Description</td><td colspan="8">Perennial river located on the farm, De Klerks Kraal</td></tr>
<tr><td colspan="2">GPS co-ordinates of sampling point</td><td colspan="8">-28.137827°S; 26.670233°E</td></tr>
<tr><td colspan="2">Quaternary Catchment</td><td colspan="8">C42L</td></tr>
<tr><td colspan="2">WMA (Midgley et al. 1994)</td><td colspan="8">Middle Vaal Water Management Area 9</td></tr>
<tr><td colspan="2">Ecoregion Name</td><td colspan="8">Highveld - Lower</td></tr>
<tr><td colspan="2">Regional Vegetation Type</td><td colspan="8">Highveld Alluvial</td></tr>
<tr><td colspan="2">Riparian Vegetation Type</td><td colspan="8">Grasses and Sedges</td></tr>
<tr><td colspan="2">Geomorphological Zonation (Rowntree and Wadeson 2000)</td><td colspan="8">Lowland river</td></tr>
<tr><td colspan="2">Channel Type:</td><td colspan="8">Valley bottom with channel</td></tr>
<tr><td colspan="2">Water Turbidity (Dallas 2005)</td><td colspan="8">Silty</td></tr>
<tr><td colspan="2">Dominant Velocity-depth Classes</td><td colspan="8">Slow shallow, Slow deep</td></tr>
<tr><td colspan="2">Dominant Biotope Diversity</td><td colspan="8">Pools and run</td></tr>
<tr><td colspan="2">Water Quality Parameters</td><td colspan="8">T(°C) = 24; pH = 7.55; EC (mS/m) = 55.50; DO (%) = 81</td></tr>
<tr><td colspan="2">Other Biota</td><td colspan="8">Fish</td></tr>
<tr><td colspan="2">Highly Sensitive Taxa (Score 11-15)</td><td colspan="8">None</td></tr>
<tr><th>DATE</th><th>SAMPLER</th><th>SASS5</th><th>ASPT</th><th>No of Taxa</th><th>PER CLASS</th><th>IHAS</th><th>IHI</th><th>MIRAI</th><th>FRAI</th></tr>
<tr><td>12/03/2022</td><td>A. Strydom</td><td>54</td><td>4.50</td><td>12</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D</td></tr>
<tr><td colspan="2">EXISTING THREATS</td><td colspan="8">• Agriculture & sand mining
• Flow modification
• Sedimentation</td></tr>
</table>

Table 7.1.3 Survey results and associated information for SD

<table>
<tr><th colspan="10">SD</th></tr>
<tr><th colspan="5">UPSTREAM</th><th colspan="5">DOWNSTREAM</th></tr>
<tr><th colspan="10">2022</th></tr>
<tr><td colspan="5"></td><td colspan="5"></td></tr>
<tr><td colspan="2">River</td><td colspan="8">Sand River</td></tr>
<tr><td colspan="2">Site Description</td><td colspan="8">Perennial river located on the farm, De Klerks Kraal</td></tr>
<tr><td colspan="2">GPS co-ordinates of sampling point</td><td colspan="8">-28.144218°S; 26.651203°E</td></tr>
<tr><td colspan="2">Quaternary Catchment</td><td colspan="8">C42L</td></tr>
<tr><td colspan="2">WMA (Midgley et al. 1994)</td><td colspan="8">Middle Vaal Water Management Area 9</td></tr>
<tr><td colspan="2">Ecoregion Name</td><td colspan="8">Highveld - Lower</td></tr>
<tr><td colspan="2">Regional Vegetation Type</td><td colspan="8">Highveld Alluvial</td></tr>
<tr><td colspan="2">Riparian Vegetation Type</td><td colspan="8">Grasses and Sedges</td></tr>
<tr><td colspan="2">Geomorphological Zonation (Rowntree and Wadeson 2000)</td><td colspan="8">Lowland river</td></tr>
<tr><td colspan="2">Channel Type:</td><td colspan="8">Valley bottom with channel</td></tr>
<tr><td colspan="2">Water Turbidity (Dallas 2005)</td><td colspan="8">Silty</td></tr>
<tr><td colspan="2">Dominant Velocity-depth Classes</td><td colspan="8">Slow shallow, Slow deep</td></tr>
<tr><td colspan="2">Dominant Biotope Diversity</td><td colspan="8">Pools and run</td></tr>
<tr><td colspan="2">Water Quality Parameters</td><td colspan="8">T(°C) = 24; pH = 7.63; EC (mS/m) = 53.20; DO (%) = 83</td></tr>
<tr><td colspan="2">Other Biota</td><td colspan="8">Fish</td></tr>
<tr><td colspan="2">Highly Sensitive Taxa (Score 11-15)</td><td colspan="8">None</td></tr>
<tr><th>DATE</th><th>SAMPLER</th><th>SASS5</th><th>ASPT</th><th>No of Taxa</th><th>PER CLASS</th><th>IHAS</th><th>IHI</th><th>MIRAI</th><th>FRAI</th></tr>
<tr><td>12/03/2022</td><td>A. Strydom</td><td>65</td><td>4.64</td><td>14</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D</td></tr>
<tr><td colspan="2">EXISTING THREATS</td><td colspan="8">• Agriculture
• Flow modification
• Sedimentation</td></tr>
</table>

7.2. Water Quality

It is important to assess WQ variables in order to determine the impacts within an ecosystem that may contribute toward changes within the biotic integrity.

Physical (in situ) and chemical water quality parameters

All the *in situ* physical and chemical variables were measured and the values along with their associated TWQRs, as defined by DWA (1996), are presented in Table 7.2.1. Each water quality parameter and the TWQR will be discussed in the section below. In the study area, the physical water quality indicated overall good results. Comparing the results with the TWQR it is observed that the water quality at the site shows no deterioration from recommended guidelines and all the values fell within the target WQ range (Table 7.2.1).

Table 7.2.1 The *in-situ* constituents analysed at the site and Target Water Quality Range (TWQR)

	TWQR[a]; SANS 241[b]	**SU**	**SM**	**SD**
pH	6-9	7.58	7.55	7.63
DO (%)	80-120	82	81	83
Temp. (°C)	5-30	24	24	24
EC (mS/m)	170	55.80	55.50	53.20

a) Target Water Quality Requirements
b) South African National Standard for Water Quality 2015

7.3. Habitat Integrity

The habitat integrities of the sites were assessed and presented in Figure 7.2-1. The riparian and instream habitats were classified as being **largely modified (D)** for all the sites sampled. In general, the deterioration of the sites was largely due to bed modifications from channel- and flow modifications (SU, SM and SD) caused by siltation, agriculture and other anthropogenic upstream activities. These habitat modifications directly and indirectly changed the biotope availability, velocity-depth flow structures, which influenced the biotic component of the ecosystem at the sites.

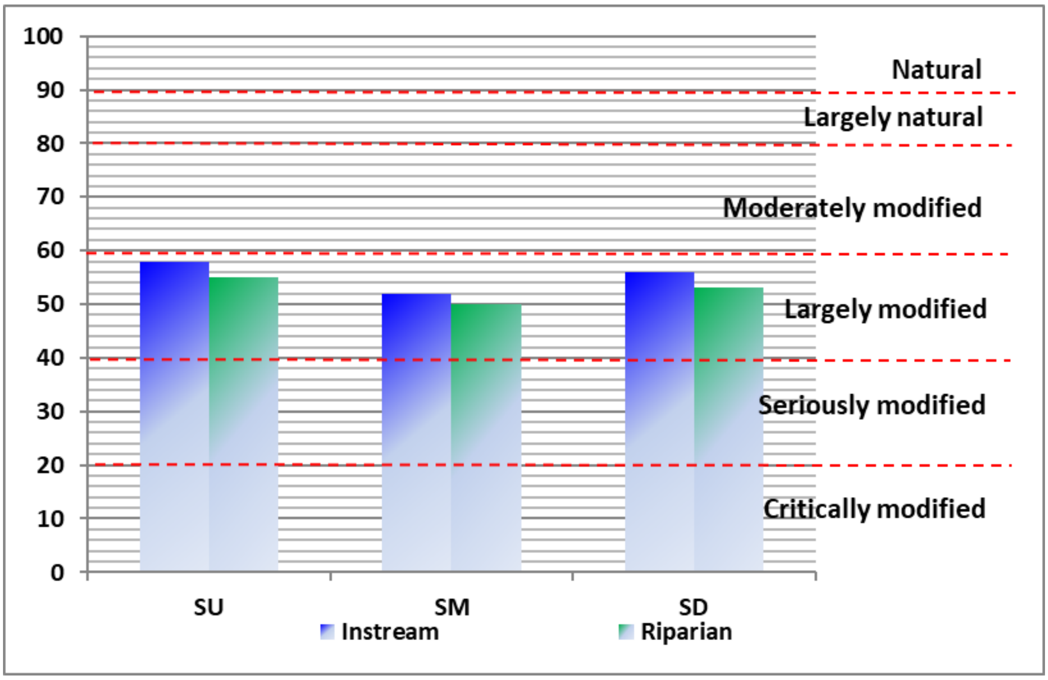


Figure 7.2-1. Habitat integrity of the instream and riparian zone at the sampling sites during the survey (as determined using HI of Kleynhans (1996)).

7.4. Macro Invertebrates

7.4.1. SASS5

The PES and impacts on the macro-invertebrate communities were assessed using SASS5 and ASPT scores according to the interpretation guidelines by Dallas (2007) and presented in Table 7.4.1.1. The family assemblages of the current assessment are represented in Appendix A. The macro-invertebrate integrity during the current survey was calculated to be **largely modified (D)** for all sites.

Table 7.4.1.1 The SASS5 result from the aquatic sampling sites during the current survey.

		Biomonitoring		
	Ref[a]	SU	SM	SD
SASS Score	123	66	54	65
ASPT	5.60	4.40	4.50	4.64
PES		D	D	D
No. of families	33	15	12	14
No. of air breathers		7	6	7
% air breathers		47	50	50
MIRAI Score	-	51	48	49
MIRAI EC	-	D	D	D

- Not available
a-Reference obtained from historical data, functional feeding groups and Ecoregion

The SASS5 and ASPT scores were used to interpret the impacts on the community assemblage during this survey. The site which had the lowest SASS5 score during the current survey was SM (54). A decrease in the SASS5 score as well as in the number of families was observed between the current assessment and reference conditions for this site (Table 7.4.1.1).

Both sites SU (15) and SD (14) indicated an increase in family numbers sampled and SASS scores (66 and 65, respectively) with regards to the middle site SM (Table 7.4.1.1). There was a slightly lower percentage of air-breathers in the macro-invertebrate integrity of site SU (47%) during the current assessment. Although an increased family diversity was observed, the absence of sensitive species resulted in a low ASPT score (4.40) for site SU. The ASPT scores indicated the family diversity mainly consisted of tolerant species resulting in all three sites to be classified as **largely modified (D)** during the current survey.

It must also be noted that the reference list of the macro-invertebrates consisted out of 33 families. From the reference list it can be indicated that the sites are impacted on because much less species (10-12) were sampled at the sites, compared to reference conditions. This result suggests that the macro-invertebrate communities were impacted due to possible deteriorated water quality and habitat, as discussed above.

7.4.2. MIRAI

The MIRAI score and EC of the current study are summarised in Table 7.4.1.1. The reference list derived for the MIRAI index had a maximum SASS5 and ASPT score of 123 and 5.60 respectively. Therefore, all sites for the current survey were calculated to being **largely modified (D),** compared to reference conditions. These modifications were due to three main causes, namely:

- A much lower number of families in comparison with the reference assemblages at both sites.
- Reduction in the number of sensitive taxa at all sites during the current survey.

A further indication that these macro-invertebrate community structures were impacted on, was through the assessment of the abundances of present families. High abundances of tolerant families such as Corixidae was observed at the sites during the current assessment. These families are predators and macrophyte piercers and are of the most common macro-invertebrates found in rivers and lakes amongst vegetation habitats.

MIRAI measures the response of the macro-invertebrates to certain drivers, namely flow, habitat and water quality. The modification in flow (caused by abstraction, impoundments, agriculture and mining) and increase of siltation with the absence of vegetation and stones biotopes, caused the absence of various families that prefer the vegetation and stones biotopes and an increase in families preferring gravel, sand and mud habitats, respectively (Table 7.4.2.1).

The MIRAI indicates that the SASS results were mainly because of the available vegetation and gravel, sand and mud (GSM) biotopes. Only the upstream site (SU) had stone biotopes available for sampling, although a very low abundance of the macro-invertebrates that mainly prefer these habitats occurred during the current survey. None of the macro-invertebrates sampled were considered to be sensitive. Therefore, MIRAI is a better indication of the macro-invertebrate community structure because it compares the reference conditions with the current conditions of these rivers.

Table 7.4.2.1 The dominant biotope diversities observed for each site by means of Dallas (2005)

Invertebrate habitat	**SU**	**SM**	**SD**
Stones in current (SIC)	2	0	0
Stones out of current (SOOC)	2	0	0
Bedrock	2	0	0
Aquatic Vegetation	1	0	0
Marg Veg in Current	2	1	1
Marg Veg out of Current	1	1	1
Gravel, sand and mud (GSM)	3	2	3
0=absent, 1=rare, 2=sparse, 3=moderate, 4=abundant and 5=very abundant			

7.5. Ichthyofauna

7.5.1. Fish habitat assessment

The location of the study area was within the Sand River catchment causing the stream to have a naturally low range of suitable habitats (Table 7.5.1.1). The sampled sites on the Sand River did not have a diverse number of habitats with no fast - flowing habitats (fast- shallow, fast-deep) available at the sites during the current survey. Therefore, the sampling at these sites were undertaken in order to describe the fish diversity.

Table 7.5.1.1 The dominant velocity-depth classes observed for each site by means of Dallas (2005)

	SU	**SM**	**SD**
Fish habitat			
Slow-deep (SD)	4	4	4
Fast-deep (FD)	0	0	0
Slow-shallow (SS)	1	1	1
Fast-shallow (FS)	0	0	0
0=absent, 1=rare, 2=sparse, 3=moderate, 4=abundant and 5=very abundant			

7.5.2. Presence of fish species

Reference list

The reference list used in current study was compiled by the most recent data provided by Kleynhans et al. (2007). The reference list consisted of nine (9) expected indigenous and three (3) alien fish species and presented in Table 7.5.2.1. The fish species that should occur in quaternary catchment C42L included *Barbus anoplus, Clarias gariepinus, Austroglanis sclateri, Labeo capensis, Labeo umbratus, Labeobarbus aeneus, Labeobarbus kimberleyensis, Tilapia sparrmanii, Pseudocrenilabrus philander* and the exotic species *Cyprinus carpio, Gambusia affinis and Micropterus salmoides.*

Table 7.5.2.1 Expected and sampled fish species for the river system associated with the Sand River.

FAMILY	SPECIES	COMMON NAME	CONSERVATION STATUS	SAMPLED
CYPRINIDAE	*Barbus anoplus*	Chubbyhead barb	LC	Yes
CLARIIDAE	*Clarias gariepinus*	Sharptooth catfish	LC	Yes
CLARIIDAE	*Austraglanis sclateri*	Rock catfish	LC	No
CYPRINIDAE	*Labeo capensis*	Orange River mudfish	LC	No
CYPRINIDAE	*Labeo umbratus*	Moggel	Introduced locally	No
CYPRINIDAE	*Labeobarbus aeneus*	Smallmouth yellowfish	LC	Yes
CYPRINIDAE	*Labeobarbus kimberleyensis*	Vaal Orange yellowfish	NT	No
CYPRINIDAE	*Pseudocrenilabrus philander*	Southern mouthbrooder	LC	Yes
CYPRINIDAE	*Tilapia sparrmanii*	Banded Tilapia	LC	Yes
Alien and Invasive Fish Species				
CYPRINIDAE	*Cyprinus carpio*	Carp	Alien	Yes
POECILIIDAE	*Gambusia affinus*	Mosquito fish	Alien	Yes
CENTRARCHIDAE	*Mycropterus salmoides*	Largemouth Bass	Alien	No
LC = Least concern; NT = Near threatened				

Species sampled

Only five (5) of the expected indigenous fish species and two (2) alien species were sampled in the current study and presented in Table 7.5.2.1 and Table 7.5.2.2.

Table 7.5.2.2 Reference and current fish frequency of occurrence

	Ref. FO	SU	SM	SD
# of indigenous species	9	**4**	**5**	**5**
Total abundances	4	**10**	**37**	**21**
# of exotic species	3	**1**	**2**	**1**
FRAI score %	NA	**48**	**44**	**46**
FRAI EC	NA	**D**	**D**	**D**
Barbus anoplus	4	3	8	1
Clarias gariepinus	4	-	1	2
Austraglanis sclateri	1	-	-	-
Labeo capensis	4	-	-	-
Labeo umbratus	4	-	-	-
Labeobarbus aeneus	4	2	2	1
Labeobarbus kimberleyensis	1	-	-	-
Pseudocrenilabrus philander	4	1	6	4
Tilapia sparrmanii	4	2	4	5
Cyprinus carpio	NA	1	1	1
Gambusia affinus	NA	2	15	8
Mycropterus salmoides	NA	-	-	-
- Not sampled; NA = Not available				

B. anoplus are hardy and their habitat preferences are predominantly slow pools with aquatic and marginal vegetation (Kleynhans, 2008; Skelton, 2001).

Lb. aeneus prefers clear-flowing waters of large rivers which has sandy or rocky substrates. They occur at higher altitudes and also in smaller tributaries than *Lb. kimberleyensis.* Breeding occurs after the first substantial rains in spring and summer (Skelton, 2001).

C. gariepinus is widely tolerant of many different habitats, even the upper reaches of estuaries, but is considered to be a freshwater species. It favours floodplains, slow flowing rivers, lakes and dams (Skelton, 2001). It can tolerate waters high in turbidity and low in dissolved oxygen and is often the last or only fish species found in remnant pools of drying rivers (Safriel & Bruton 1984, Van der Waal 1998).

T. sparrmanii and *P. philander* occurs in widely diverse habitat and favors areas where plant cover exists along the edges of rivers, lakes or swamps (Skelton, 2001). These species prefer shallow sheltered waters and does not colonize the open water.

The alien invasive species *G. affinis* were intentionally introduced in many areas with large mosquito populations to decrease the population of mosquitoes by eating the mosquito larvae (Skelton, 2001). They are found most abundantly in shallow water where they are protected from larger fish. This species can survive relatively inhospitable environments, and are resilient to low oxygen concentrations, high salt concentrations and also temperature variations (Skelton, 2001). They have been known for their aggressive behaviour towards other fish species. The presence of *C. carpio*, which can prey on fish eggs and causes bio-turbation, may also negatively impact on the fish species present in the system.

Species not sampled

The expected indigenous and alien species that were not sampled during the current survey included *L. umbratus*, *L. capensis, Lb. kimberleyensis, A. sclateri* and *M. salmoides* (Table 7.5.2.2).

Lb. kimberleyensis, which has a conservation status according to the IUCN and considered to be near threatened (NT), favours good habitats with fast flowing water and deep pools but are also found in large dams. These species are moderately intolerant to no flow and their cover preference includes a very high-water column (Kleynhans, 2008; Skelton, 2001; Scott *et al.* 2006).

Austroglanis sclateri prefers rocky habitat in mainstream areas of major rivers. It is omnivorous and feeds on invertebrates especially from rock surfaces with larger specimens also feeding on small fish (Skelton 2001).

L. umbratus prefers standing or slow flowing water and thrives in shallow impoundments and farm dams (Skelton 2001; Scott *et al.* 2006). They are tolerant to modified water quality conditions (Kleynhans 2008) and because they were locally introduced, it is possible that they might not occur in the area of sampling.

L. capensis prefers running waters of large rivers but also survives well in large impoundments. They gather in shallow rocky rapids where they breed during the summer season.

The exotic species *Micropterus salmoides,* favours clear standing waters, with submerged and floating vegetation (Skelton, 2001). This fish species will feed on the little indigenous species within a system. The reason for this species not sampled during the survey might be due to the absence of deep clear water habitats with submerged and floating vegetation at the study area.

7.5.3. FRAI

The PES for the sites sampled during the current survey was **largely modified (D)** (Table 7.5.2.2.). The baseline study indicates that there is a deterioration in the fish community assemblages in the area compared to expected reference list. This was because only seven (7) of the 12 expected species were sampled.

Although, only seven of the reference list species were sampled of the possible 12 at the sites, all of the twelve species expected under reference conditions are still expected to be present under the present conditions at these sites and in the river. This was probably as a result of reduced habitat availability and also the migration barriers formed by the weirs present upstream of the site. It is expected that species which are moderately intolerant to no flow conditions (*Lb. kimberleyensis* and *A. sclateri*) will still be present as they will survive and be sustained in the current habitat for extended periods, but that their spawning success and recruitment will be reduced.

Due to flow modification and floods, there is a loss of FD and FS habitats as well as substrate as cover, reducing the occurrence of *A. sclateri*, *L. umbratus* and *Lb. kimberleyensis*. Deep pools are present, and all the species will be able to utilise the pools as cover and refugia.

The presence of the alien species *G. affinis* (mosquitofish) and *C. carpio* (carp) at all of the sites may also have an impact on the occurrence of indigenous species as these species are known to impact other species in competition for suitable breeding habitat.

The current survey indicates that there is deterioration in the fish community assemblages in the area compared to expected reference list. This may be attributed at least in part to an overestimation of the expected fish species at the sites. Further, due to flow and channel modifications and severe siltation there is a loss in available habitats which may also have an impact on the occurrence of indigenous species.

8. Current Impacts on Aquatic Ecosystems

The current aquatic impacts are summarised below:

- The aquatic habitats were impacted due to general catchment activities including upstream agricultural and anthropogenic activities and weirs that induced modifications to flow regime, in-stream channel, and water quality.
- The aquatic biota was also modified from natural assemblages. The macro-invertebrate assemblages were largely modified due to alterations in the habitat and abundance of tolerant families. The fish assemblages were also impacted, with only 7 of the expected fish species present during this study due to modified habitat and flow at the sites.

9. Possible Impacts from the Sand Mine

The possible future impacts from the sand mine development on the freshwater biota are given below:

- Flow and channel modification
- Increased turbidity and siltation of the river and aquatic habitats.
- Potential loss of aquatic habitats.

10. Possible Mitigation Measures

Possible mitigation measures towards future impacts from the sand mine development on the freshwater biota are given below:

- The extent of the sand mining area should be limited in order to minimise environmental damage.
- The extraction of river sand should be conducted sustainably and must not compromise the flow of the river or divert the main flow of the river.
- Monitor *in-situ* water quality (including turbidity) upstream and downstream of the mine extent on a monthly basis during extraction activities.

All rehabilitation and monitoring measures must ensure that disturbed areas are rehabilitated to pre-mining conditions.

11. Conclusion

The aquatic ecosystem within the surrounding area of the sand mine was assessed as being **largely modified (D)** in relation to the habitat integrity, macro-invertebrate as well as for the fish assessment, after the current survey. The majority of the impacts on this system were associated with agriculture, existing sand mines and instream habitat changes. These modifications in turn influenced the macro-invertebrate and fish community structures. The physical water quality results during the current survey indicated that the water quality was generally good at all of the sites. The main sources for the absence of the expected fish species and macro-invertebrates at all the sites assessed, were from the absence of suitable habitat due to siltation, agriculture and general anthropogenic activities.

As the study area does not fall within a Freshwater Ecological Protected Area (FEPA) it is not governed by its stringent management guidelines. However, normal guidelines should still be adhered to in regards to any development as well as future management of the river. The impacts of the sand mine in the system were found to cause potential loss of aquatic habitat and increased turbidity and siltation in the river. The possible impacts will have an effect on the water quality and also on the biotic integrity of the system and needs to be continuously monitored to limit any adverse effects.

12. Recommendations for future monitoring

- Continued bi-annual monitoring of the habitat, macro-invertebrate and fish communities at these sites, which vary seasonally.
- Monitor siltation within the river segment downstream of activities.

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Appendix

Appendix A Biomonitoring Data for the current assessment – March 2022

TAXON	**SU**	**SM**	**SD**
PORIFERA (Sponge)	-	-	-
COELENTERATA (Cnidaria)	-	-	-
TURBELLARIA (Flatworms)	-	-	-
ANNELIDA Oligochaeta (Earthworms)	A	-	-
Hirudinea (Leeches)	-	-	-
CRUSTACEA Amphipoda (Scuds)	-	-	-
Potamonautidae* (Crabs)	-	-	-
Atyidae (Freshwater Shrimps)	B	A	A
Palaemonidae (Freshwater Prawns)	-	-	-
HYDRACARINA (Mites)	-	-	-
PLECOPTERA (Stoneflies) Notonemouridae	-	-	-
Perlidae	-	-	-
EPHEMEROPTERA (Mayflies) Baetidae 1sp	-	-	-
Baetidae 2spp	B	B	B
Baetidae >2spp	-	-	-
Caenidae (Squaregills/Cainfles)	1	-	1
Ephemeridae	-	-	-
Heptageniidae (Flatheaded mayflies)	-	-	-
Leptophlebiidae (Prongills)	-	-	-
Oligoneuridae (Brushlegged mayflies)	-	-	-
Polymitarcyidae (Pale Burrowers)	-	-	-
Prosopistomatidae (Water specs)	-	-	-
Teloganodidae SWC (Spiny Crawlers)	-	-	-
Tricorythidae (Stout Crawlers)	-	-	-
ODONATA (Dragonflies & Damselflies) Calopterygidae ST,T (Demoiselles)	-	-	-
Chlorocyphidae (Jewels)	-	-	-
Synlestidae (Chlorolestidae)(Sylphs)	-	-	-
Coenagrionidae (Sprites and blues)	A	A	A
Lestidae (Emerald Damselflies/Spreadwings)	-	-	-
Platycnemidae (Stream Damselflies)	-	-	-
Protoneuridae (Threadwings)	-	-	-
Aeshnidae (Hawkers & Emperors)	-	-	-
Corduliidae (Cruisers)	-	-	-
Gomphidae (Clubtails)	A	1	1
Libellulidae (Darters/Skimmers)	-	-	-
LEPIDOPTERA (Aquatic Caterpillars/Moths) Crambidae (Pyralidae)	-	-	-
HEMIPTERA (Bugs) Belostomatidae* (Giant water bugs)	1	1	A
Corixidae* (Water boatmen)	B	B	A
Gerridae* (Pond skaters/Water striders)	-	-	-
Hydrometridae* (Water measurers)	-	-	-
Naucoridae* (Creeping water bugs)	-	-	-
Nepidae* (Water scorpions)	-	-	-
Notonectidae* (Backswimmers)	A	A	1
Pleidae* (Pygmy backswimmers)	A	1	1
Veliidae/M...veliidae* (Ripple bugs)	A	A	A
MEGALOPTERA (Fishflies, Dobsonflies and Alderflies) Corydalidae (Fishflies & Dobsonflies)	-	-	-
Sialidae (Alderflies)	-	-	-
TRICHOPTERA (Caddisflies) Dipseudopsidae	-	-	-

TAXON	SU	SM	SD
Ecnomidae	-	-	-
Hydropsychidae 1 sp	-	-	-
Hydropsychidae 2 sp	-	-	-
Hydropsychidae > 2 sp	-	-	-
Philopotamidae	-	-	-
Polycentropodidae	-	-	-
Psychomyiidae/Xiphocentronidae	-	-	-
Cased caddis: Barbarochthonidae SWC	-	-	-
Calamoceratidae ST	-	-	-
Glossosomatidae SWC	-	-	-
Hydroptilidae	-	-	-
Hydrosalpingidae SWC	-	-	-
Lepidostomatidae	-	-	-
Leptoceridae	-	-	-
Petrothrincidae SWC	-	-	-
Pisuliidae	-	-	-
Sericostomatidae SWC	-	-	-
COLEOPTERA (Beetles) Dytiscidae/Noteridae* (Diving beetles)	1	1	A
Elmidae/Dryopidae* (Riffle beetles)	-	-	-
Gyrinidae* (Whirligig beetles)	A	-	1
Haliplidae* (Crawling water beetles)	-	-	-
Helodidae (Marsh beetles)	-	-	-
Hydraenidae* (Minute moss beetles)	-	-	-
Hydrophilidae* (Water scavenger beetles)	-	-	-
Limnichidae (Marsh-Loving Beetles)	-	-	-
Psephenidae (Water Pennies)	-	-	-
DIPTERA (Flies) Athericidae (Snipe flies)	-	-	-
Blepharoceridae (Mountain midges)	-	-	-
Ceratopogonidae (Biting midges)	-	-	-
Chironomidae (Midges)	A	A	A
Culicidae* (Mosquitoes)	-	-	-
Dixidae* (Dixid midge)	-	-	-
Empididae (Dance flies)	-	-	-
Ephydridae (Shore flies)	-	-	-
Muscidae (House flies, Stable flies)	-	-	-
Psychodidae (Moth flies)	-	-	-
Simuliidae (Blackflies)	1	B	1
Syrphidae* (Rat tailed maggots)	-	-	-
Tabanidae (Horse flies)	-	-	-
Tipulidae (Crane flies)	-	-	-
GASTROPODA (Snails) Ancylidae (Limpets)	-	-	-
Bulininae*	-	-	-
Hydrobiidae*	-	-	-
Lymnaeidae* (Pond snails)	-	-	-
Physidae* (Pouch snails)	-	-	-
Planorbinae* (Orb snails)	-	-	-
Thiaridae* (=Melanidae)	-	-	-
Viviparidae* ST	-	-	-
PELECYPODA (Bivalves) Corbiculidae (Clams)	-	-	-
Sphaeriidae (Pill clams)	-	-	-
Unionidae (Perly mussels)	-	-	-